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CAN CLIMATE KNOWLEDGE LEAD TO BETTER RURAL POLICIES AND RISK MANAGEMENT PRACTICES?

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BACKGROUND

In many parts of the world, climate is one of the biggest risk factors impacting on agricultural systems performance and management. Climate variability (CV) and climate change (CC) contributes to the vulnerability of individuals, businesses, communities and regions. Extreme climate events such as severe droughts, floods, cyclones or temperature shocks often strongly impede sustainable agricultural development. Targeted and appropriately conceptualised climate knowledge (including seasonal climate forecasting and scenario analyses) can increase overall preparedness and lead to better social, economic and environmental outcomes.

Climate variability occurs over a wide range of temporal scales. Our increasing understanding of the underlaying mechanisms means that some of that variability is now predictable. Research efforts are directed towards investigating phenomena such as the Madden-Julian Oscillation (MJO; 30-60 days), ENSO related variability (2.5 - 8 years), decadal and multidecadal climate variability and climate change.

The challenge is to use this climate knowledge operationally to achieve two key outcomes: a) policies suitable for multi-goal objectives resulting in rapid and substantial societal benefits and b) risk management strategies that reduce vulnerability for individuals and businesses. This requires the ability and willingness to adapt and change the way we do things.

DISCUSSION

‘Adaptation’ (meaning ‘responsive adjustment’) is the implementation of prevention strategies that reduce the impact of risks associated with CV or CC. For agriculture, we argue that the difference between adapting to CV versus adapting to CC is often only a matter of time horizon (temporal scale).

Good data, modelling and knowledge about CV and CC impacts have to influence long-term policy development in order to ensure that policies are congruent with actions that need to be taken by land managers. Land managers, however, do not experience CC directly – on a season-by-season basis, the consequences of CC are indistinguishable from CV. Hence, at the field and farm level, adaptation responses that have been developed due to knowledge of CV are equally relevant for CC related issues. Exceptions might be extremely marginal regions, where very small changes in climatic conditions could render the entire production system unprofitable or unsustainable within a short period of time or systems that require large, initial capital investments that may not be repaid for decades (eg. plantations in horticulture or forestry, long-lived infrastructure). Land managers, industry leaders and policy makers have a choice: they can either adapt to minimise negative impacts and even capitalise on the upsides of CV/CC or they can ignore it, thereby accepting the consequences of increased risk.

The Australian case

CV and its interaction with land management has major impacts on Australian agriculture. Extreme climate events can dramatically affect farm level productivity (Hammer et al., 2000; Meinke et al., 2003b). Droughts and floods also affect the entire Australian economy, including macroeconomic indicators (White, 2000). In some regions, extreme climate events combined with factors such as overgrazing have resulted in major long-term resource degradation (McKeon et al., 1990).To capitalise on the ever increasing understanding of causes and consequences of CV and CC, agencies across Australia are engaging in participatory, cross-disciplinary research that brings together institutions (partnerships), disciplines (eg. climate science, agricultural systems science, sociology and many other disciplines) and people (scientists, policy makers and direct beneficiaries) as equal partners to reap the benefits from agricultural systems and climate research. To be most effective, these partnerships must include the private sector, eg. consultants, banks and insurance companies. Climate science can provide insights into climatic processes, agricultural systems science can translate these insights into management options and social scientists can help to determine the options that are most feasible or desirable from a socio-economic perspective. This approach has to influence simultaneously policy formulation and operational risk management to ensure optimal societal benefits. Any scientific breakthroughs in climate knowledge are much more likely to have an immediate and positive impact if they are conducted and delivered within such a framework (Meinke et al., 2001; Meinke and Stone, 2004).

Adoption to CV and CC can be reactive or proactive, a point, which we will illustrate here: In some parts of Australia increases in minimum temperatures have already significantly reduced the frost risk for wheat. At Emerald (23^{o}S, 148^{o}E, Central Queensland, Australia), spring wheat is sown in late autumn and optimal yields are obtained from crops flowering as close to the end of the frost period as possible, but frost during the flowering period can result in total crop failure. In this region, the frost risk period has been reduced from approximately 80 days at the end of the 19th century to about 20 days today (Fig. 1; Howden et al., 2003b). Baethgen et al. (2003) found a similar trend for Estanzuela, SW Uruguay (34°S, 57°W), where the frost period was reduced from 15 weeks in 1915 to 9 weeks in 2002. At Emerald, wheat is now sown earlier and maturity types have been adapted accordingly (Meinke et al., 2003a). This shows that in some agricultural systems such as in NE Australia we are already seeing a degree of autonomous adaptation (reactive adaptation) to CC. Good risk management suggests that this autonomous adaptation needs to be supplemented by planned, proactive adaptation. This requires policy frameworks that encourage and promote such proactive risk management strategies. Proactive adaptation (eg. initiating selection for varieties suited to future climates and CO_2 levels in the example above) will also be a necessary strategy at national and local scales to complement CC mitigation efforts (Howden et al. 2003a).

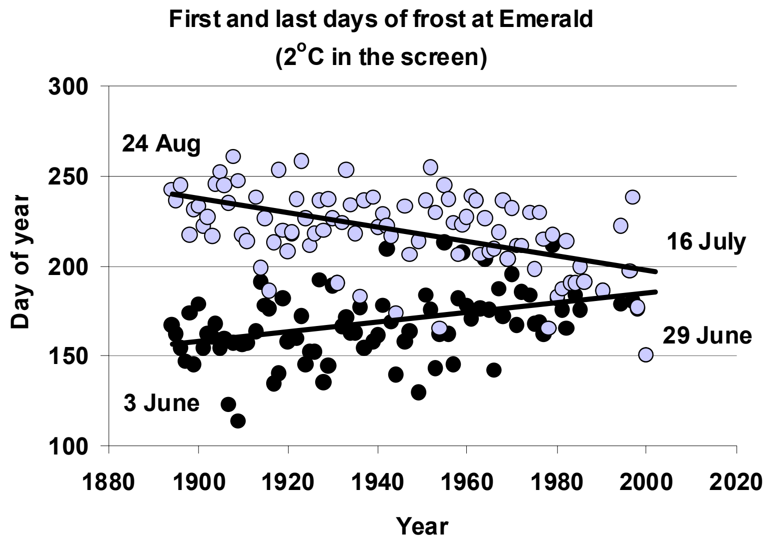

Figure 1. Changes in the dates of first and last frost at Emerald (NE Australia) during the last century (expressed as a screen temperature of 2°C or lower).

Extreme events also require multidimensional risk analyses, because risks and stresses to which agricultural systems are exposed can arise from a wide variety of sources. It is important, for instance, to differentiate between buffered systems that can absorb certain climatic shocks from systems that exhibit well-defined sensitivity thresholds that, once exceeded, will lead to a catastrophic systems collapse (eg. Gunderson et al. 1995). Again, careful systems analysis is required to recognise and quantify such thresholds.

A global approach?

The global impact of climate variability has contributed to the establishment of pilot programmes around the world that aim to bring about significant societal benefits through targeted adaptation to CV. These pilot studies bring together climate scientists, agronomists, crop modellers and farmers to discuss options and their consequences. Examples are some of the coordinated research efforts in Australia (Nelson et al., 2002) and the close links that Australian scientists have established with, for instance, the International Research Institute for Climate Prediction (IRI) at Colombia University, NY and scientists in developing countries (Meinke and Stone, 2004). The number of research groups actively engaged in these issues is rapidly increasing and interested readers are referred to publications in special issues of Agriculture and Forest Meteorology (2000), Vol 103, Agricultural Systems (2001 and 2002), Vols 70 and 74 and Hammer et al. (2000) for further details. The value of such a systems approach to CV and CC has also been recognised by international bodies who now support such research activities in many developing countries throughout Asia, Africa and South America (eg. APN, ADPC, IAI, START and NOAA-OGP).

With the help of these agencies and the international agricultural modelling community these pilot projects provide a means to assess the potential value of climate knowledge to agricultural in developing countries (Sivakumar, 2000). This has lead to the establishment of a loose network, known as RES AGRICOLA (Latin for Farmers' business), that draws on the collective expertise of the global research community to develop resilient farming systems (Meinke and Stone, 2004). These are systems that are to a large extent 'climate proof' by allowing farmers to draw on systems resources (eg. water, nutrients, reserves) at times of need, with these 'debts' being repaid once climatic conditions improve.

Following is a brief example that illustrates the *modus operandi* of these community-focused pilot studies in developing countries:

In June 2002, in the village of Thamaraikulam, Tamil Nadu, India, the forecast of a greater chance of below normal summer monsoon rainfall (June-September) based on the April/May (falling) and May/June (negative) SOI phases (Stone et al., 1996) was discussed with nearly 30 farmers in group sessions. APSIM simulation output (Keating et al., 2003) was used to discuss crop management options to reduce risk (eg. crop choice, planting density). The simulations indicated high chances of reduced peanut yield that could be mitigated by reducing plant populations. The model further suggested sorghum as a viable alternative to cotton under very dry conditions. These simulation outputs were discussed in village meetings and the discussions had significant impact. The options derived from simulation model output and used as a basis for an informed debate ('discussion support', Nelson et al., 2002) have demonstrably changed the cropping area. Many farmers changed from growing cotton in June to early sorghum, while others also reduced population densities, harvesting at least 0.8 t/ha of peanut. However, crop choice decision was key with more that 70% of farmers growing some sorghum instead of cotton. The ca 20% of farmers, who took the risk and planted cotton had to abandon their crops by August, loosing all their input costs. These changes in management practice were clearly the result of using quantitative data from simulation models as discussion support.

This simple example demonstrates that the combination of systems analysis, climate science, quantitative simulation tools, discussion support and community interactions can be an extremely effective way to ensure societal benefits based on climate knowledge.

ISSUES AND LESSONS LEARNED

The high levels of uncertainty in future climate changes suggest that rather than try to manage for a particular climate regime, we need more resilient agricultural systems (including socio-economic and cultural/institutional structures) to cope with a broad range of possible changes. However, enhanced resilience usually comes with various types of costs or overheads such as building in redundancy, increasing enterprise diversity and moving away from systems that maximise efficiency of production at the cost of broader sustainability goals.

Better risk management through cross-disciplinary approaches

We need to focus on risk management, rather than on specific disciplines, and cross-disciplinary approaches to have an impact. Risk management has many dimensions requiring cross-disciplinary approaches to be effective ('integrated assessments to vulnerability'). Climate is only one of these dimensions (albeit often with dominating consequences, particularly in developing countries), but climate-related knowledge can result in choices that either reduce risks or improve returns. Conversely, there are times and locations when and where even the best knowledge of climatic conditions (past, present and future) will not alter any decisions. The ability to distinguish between these two situations and to take appropriate action based on knowledge rather than ignorance separates good risk managers from the rest.

Learning from CV to adapt to CC

We need to build on lessons learnt from coping with CV. A systematic evaluation of management options that take existing CV into account can be easily adapted to evaluate systems performance for future CC scenarios. If we can handle CV, we can also cope with CC, providing policy formulation and changes to risk management practices are congruent and happen in a consultative and negotiated way.

Improving forecasting capabilities

More accurate and longer-lead forecasts remain a key research priority. Statistically based climate forecasting has become an important component in managing climate variability risks in agriculture. However, such statistical methods might have reached their 'limits of predictability', making a major breakthrough in statistical forecasting unlikely (Meinke and Stone, 2004). Furthermore, the increasing evidence for climate change raises questions about the representativeness of the historical statistical relationships for current decisions. This means that any future breakthroughs are likely to be associated with GCMs. World-wide millions of dollars are spend on GCM development, but successful applications are still rare. Although GCM output is used to inform the policy process, GCM output needs to be 'downscaled' in some form before it can be used for operational risk management, particularly in conjunction with biological simulation models. There is still no agreed method how appropriate downscaling can be achieved. Hence, GCMs - in spite of their potential - do not contribute in any substantial way to operational CC/CV associated risk management.

Providing a cohesive framework for policy and risk management

Currently informing the policy process largely occurs through the climate change community using GCMs; input into production risk management is largely provided via the climate variability community using statistical forecasts in conjunction with dynamic farming systems simulation models. To ensure that risk management practices and policies are 'in tune' will require a more coherent approach to simultaneously influencing policy and risk management decisions based on common data sources and tools. If we consider CC as a low frequency mode of CV (thereby considering all frequency domains that impact on systems performance) then we might overcome the chasm that currently exists between policy development and climate risk management of agricultural systems due to differences in methodologies, temporal and spatial scales.

Stakeholder involvement – a key to success
Agricultural policies and risk management practices could benefit from the emerging, globally coordinated, cross-disciplinary research networks that use a common methodology and research approaches to address locally relevant issues in a participatory fashion. Stakeholder support for the approach and stakeholder involvement in the process is critical for success. Stakeholders have to 'own' the problems as well as the solutions. Such an approach will allow the quantification of alternative options, thus assisting in achieving negotiated, multi-goal objectives with benefits to individuals and societies.

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